The Organic Chemistry of Polymers - CHM 4272 Syllabus

CHM 4272-2993, Spring 2009, Tuesday, Thursday, 10:40 am – 11:30 am, Room LEI 242
Professor Stephen A. Miller, Office: LEI 318A, miller@chem.ufl.edu

Course Description. Classification of polymerization types and mechanisms from a mechanistic organic point of view. The structure of synthetic and natural polymers and polyelectrolytes. Reaction of polymers. Practical synthetic methods of polymer preparation.

Course Coverage. Mechanisms of polymerization reactions of monomers and molecular weight distributions of products; principles, limitations, and advantages of most important methods of molecular weight determination; relationship of physical properties to structure and composition; correlations of applications with chemical constitution. Topics will include: basics of polymerization; condensation polymerization, radical chain polymerization, ionic chain polymerization, copolymerization, ring-opening polymerization, metal-catalyzed polymerization, chemical modifications of polymers, recent developments in polymers, polymer characterization, polymer properties, and biological polymers.

Prerequisites. CHM 2210, 2211 (sophomore organic chemistry) or equivalent.

Recommended. CHM 3120 (junior analytical chemistry) or equivalent.

Course Goals.

- Deduction of monomer(s) given a polymeric structure
- Deduction of polymer given a monomeric structure
- Understanding basic techniques for polymer characterization
- Understanding of molecular weight and molecular weight distributions
- Understanding of basic techniques for molecular weight determination
- Understanding of polymerization mechanisms
- Recognition of compatibility of monomers with various polymerization mechanisms/reaction conditions
- Understanding polymer structure/polymer property relationships
- Classification of polymers based on chemical structure

1	January 6	Introduction/Overview, Polymer History, Definitions **Preface, 1.1–1.2**
2	January 8	Polymerization Processes **1.3–1.6**
3	January 13	Nomenclature **1.7, Appendix A**
4	January 15	Industrial Polymers, Polymer Recycling **1.8–1.9**
5	January 20	Molecular Weight, Measurement of Molecular Weight **2.1, 2.6.1**
6	January 22	Polymer Structure and Morphology **3.1–3.2, 3.3 (pp. 63, 67–68), 3.4–3.5** PS#1
7	January 27	Polymer Structure and Morphology, Mechanical Properties **3.6, 3.8–3.9, 4.1, 4.3–4.4**
8	January 29	Polymer Properties, Polymer Characterization **4.6–4.7, 5.1–5.2, 5.3.3, 5.5.1, 5.6.1, 5.6.3** PS#2
9	February 3	**Midterm Examination I.** (Chapters 1–5)
10	February 5	Free Radical Polymerization, Initiators, Kinetics, Mechanism **6.1–6.2 (not 6.2.3, 6.2.6), 6.4**
11	February 10	Free Radical Polymerization, Stereochemistry, Dienes, Reactivity,Copolymerization **6.5–6.8**
12	February 12	Ionic Polymerization, Cationic Polymerization **7.1, 7.2.1–7.2.2, 7.2.5**
13	February 17	Ionic Polymerization, Anionic Polymerization, GTP **7.3–7.4**
14	February 19	Coordination Polymerization, Heterogeneous Ziegler-Natta **8.1–8.2** PS#3
15	February 24	Homogeneous Z-N, Z-N Copolymerization, Olefin Metathesis Polymerization **8.3–8.4, 8.7**
16	February 26	Reactions of Vinyl Polymers, Functional Group and Ring-Forming Reactions **9.1–9.3**
17	March 3	Reactions of Polymers, Crosslinking, Block and Graft, Degradation **9.4–9.6** PS#4
18	March 5	**Midterm Examination II.** (Chapters 6–9)
	March 10	**No Class.** Spring Break
	March 12	**No Class.** Spring Break
19	March 17	Step-Reaction Polymerization, Kinetics, Molecular Weight, Copolymerization **10.1–10.2, 10.4, 10.6**
20	March 19	Step-Reaction Polymerization, Techniques, Dendrimers, Ring-Opening **10.7–10.9**
21	March 24	Polyethers, Preparation, Properties **11.1–11.2**
22	March 26	Polyesters, Preparation, Properties **12.1–12.2** PS#5
23	March 31	Polycarbonates, Preparation, Properties **12.2.2**
24	April 2	Polyamides, Preparation, Properties **13.1–13.3** PS#6
25	April 7	**Midterm Examination III.** (Chapters 10–13)
26	April 9	Phenol-, Urea-, and Melamine-Formaldehyde Polymers **14.1–14.3, 14.5–14.6**
27	April 14	Inorganic and Partially Inorganic Polymers, Polysiloxanes, Polyamines **16.1, 16.3, 17.7**
28	April 16	Natural Polymers, Miscellaneous Natural Polymers, Polysaccharides **18.1–18.3**
29	April 21	Natural Polymers, Proteins, Nucleic Acids, **18.4–18.5** PS#7
30	May 1	**Final Exam.** (Cumulative) Friday, May 1st, 10:00 am – 12:00 noon, LEI 242

Required Textbook: Stevens, M. P. ***Polymer Chemistry: An Introduction,*** *Third Edition*; Oxford University Press: New York, **1999**. (ISBN 0195124448; amazon.com, $96.00).

Highly Recommended Textbook: Odian, G. ***Principles of Polymerization****, Fourth Edition*; Wiley-Interscience: New York, **2004**. (ISBN 0471274003; amazon.com, $98.42).
http://www.netLibrary.com/urlapi.asp?action=summary&v=1&bookid=106946
(E-book, licensed for UF; free from within the UF firewall, http://www.netlibrary.com/Search/BasicSearch.aspx)

Recommended Textbooks:
1) Fried, J. D. ***Polymer Science and Technology***; Pretence Hall: Englewood Cliffs, New Jersey, **1995**.
2) Carraher, C. E. ***Polymer Chemistry****, Sixth Edition*; Marcel Dekker: New York, **2003**.
3) Matyjaszewski, K.; Davis, T. P. ***Handbook of radical polymerization***; Wiley-Interscience: Hoboken, N.J., **2002**.
http://www.netLibrary.com/urlapi.asp?action=summary&v=1&bookid=85508
4) Kuran, W. ***Principles of coordination polymerisation: heterogeneous and homogeneous catalysis in polymer chemistry-polymerisation of hydrocarbon, heterocyclic, and heterounsaturated monomers***; John Wiley: Chicthester, England, **2001**.
http://www.netLibrary.com/urlapi.asp?action=summary&v=1&bookid=78966
5) Brandrup, J.; Grulke, E. A.; Immergut, E. H. ***Polymer handbook***; Wiley: New York, **1999**.
http://www.knovel.com/knovel2/Toc.jsp?BookID=1163

WebCT/E-Learning. All students will have access to WebCT/E-learning. The homepage for this course can be found at:

https://elearning.courses.ufl.edu/webct

You will login with your Gatorlink account username and password. This is where you will find general class information, important news, office hours, handouts, class notes, and keys. This is also where you will be able to find out your point totals and histograms.

Class Requirements:

1) Seven problem sets (35 points each; 210 points max; the lowest score will be dropped)
2) Ten in-class quizzes (10 points each = 100 points)
3) Three midterm examinations (150 points each = 450 total)
4) Final examination (240 points)

= 1000 points total

Problem Sets. Problem sets will be **due at 4:00 pm** on the designated due dates. Answer keys will be posted around this time. Please write only on the paper provided. The problem sets may be spot-graded; this means that only some or parts of the problems may be scored and contribute to the 35 points. The lowest of the seven scores will be dropped. You may work in groups or alone. But, you may not copy answers. The problem sets are designed to prepare you for the examinations. Problem sets cover the following chapters:

PS#1 Chapters 1–2
PS#2 Chapters 3–5
PS#3 Chapters 6–7
PS#4 Chapters 8–9
PS#5 Chapters 10–12
PS#6 Chapters 12–13
PS#7 Chapters 14, 16–18

In-class Quizzes. The ten in-class quizzes, which will be unannounced and randomly distributed during the semester, will be short and are designed to encourage you to attend class and to keep up with the course. They may occur at the beginning, middle, or end of class. They should be very easy for those who have read the assigned material. The quizzes can only be taken during the class period in which they are administered. They cannot be made up.

Midterm Examinations. There will be three midterm examinations and each will focus on the chapters designated. The midterms are not designed to be cumulative; but you may expect some natural amount of material from a previous midterm to be important and necessary.

Final Examination. The final examination will be cumulative. The best way to study for it is to keep up during the semester and review all notes and assignments for the course.

Extra Credit. Additional opportunities *should* arise for extra credit (*e.g.*, extensive class participation, attending a lecture outside of class, extra credit quizzes, extra credit problems on the homework, or an extra credit question on an exam). In any event, no more than 50 extra credit points may be earned. Extra credit will be applied after the curve is assigned for the course. This may allow some students to raise their grade by—at most—two grade increments (for example from a B to an A, but not from a C+ to an A).

Grading. Grades will be curved based on points earned out of 1000. The extra-credit will then be added to those who have earned it to determine if an increase in the final grade is achieved.

Assignment Regrading. If you have a question concerning the grading of an assignment, you may submit the entire assignment for complete regrading. The assignment must be submitted for regrading by the second class meeting after the date the assignment was returned to the class. Note that our Final exam will be given on May 1st, the last day of finals for Spring 2009. Grading disputes with the Final Exam must be addressed by Saturday, May 2nd, according to a time schedule that will be announced.

Online Notes will be available at WebCT (see above) in pdf format. They are organized by book chapter. They are made and posted to help you follow the lecture; hopefully this will allow you to spend less time writing and more time thinking. Students are encouraged to print the notes and bring them to class to facilitate notetaking. Except for Chapter 1, they will not be available in class.

Office Hours. Office hours will be scheduled prior to each problem set and examination. Additional office hours should be possible and should be scheduled by email. They will likely be held in LEI 328.

Makeup Examinations. Makeup examinations will be given only for University-excused absences provided the appropriate documentation is supplied within the allowed timeframe.

Returning Assignments. To facilitate the return of assignments, I request that you write your name and class number (to be assigned) on the back (top 1 inch) of each assignment that is turned in. Thus, I will be able to turn them upside-down and alphabetize them for mass distribution on a table at the front of class.

UF Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.

On all work submitted for credit by students at the university, the following pledge is either required or implied: **"On my honor, I have neither given nor received unauthorized aid in doing this assignment."** "The university requires all members of its community to be honest in all endeavors. A fundamental principle is that the whole process of learning and pursuit of knowledge is diminished by cheating, plagiarism and other acts of academic dishonesty. In addition, every dishonest act in the academic environment affects other students adversely, from the skewing of the grading curve to giving unfair advantage for honors or for professional or graduate school admission. Therefore, the university will take severe action against dishonest students. Similarly, measures will be taken against faculty, staff and administrators who practice dishonest or demeaning behavior."

Cheating and Plagiarism. Cheating and/or plagiarism will not be tolerated. The minimum penalty will be an automatic zero on the assignment in question. Suspension from the University may also result. Do not risk it. It is not worth it. Plagiarism consists of passing off as one's own the ideas, words, writings, etc. that belong to someone else. You are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have that person's permission. See:

http://www.registrar.ufl.edu/catalog/policies/students.html
http://www.dso.ufl.edu/judicial/honorcode.php
http://www.dso.ufl.edu/judicial/academic.php